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ORIGINAL PAPER

Effect of intervention and type of forest management on quality and quantity characteristics of dead wood in managed and reserve forests: A case study

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Abstract: We compared the dead wood (DW) conditions of Cheshmeh-sar forest and Sardab forest with different management history, including reserve forest and harvested forest. The First forest took 100% inventory from all the available DW. Also dead trees were compared in terms of species, shape, location and quality of fracture in both forests. Volumes of dead wood in Cheshmeh-sar and Sardab forests were 207.47 and 142.74 m³, respectively. Due to this significant difference, impact on the management level was determined. In Cheshmeh-sar forest, 42% of dead trees were standing and 58% were fallen type while in Sardab forest 38.6% were standing and 61.4% fallen. But the difference was not statistically significant between them (p = 0.0587). In terms of quality, dead trees of hard, soft and hollow had the highest frequency, respectively. However, 71.5% of DW was seen as hard dead in Cheshmeh-sar forest while hard dead trees in Sardab forests were 54.2%. Soft quality degree of dead trees which formed in Cheshmeh-sar and Sardab forest were calculated as 26.6% and 43.4% respectively. Also 30% of the dead trees of Sardab forest were eradicated while in Cheshmeh-sar this amount was reduced to 12%. Due to this significant difference ((P=0/018), it is concluded that the type of management and human interference are affecting the quality of dead trees and makes us to think the human interferences could effect on the ecosystem of touched forests.

Keywords: dead wood; intact forests; managed forest; reserve forest; North of Iran

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Introduction

Dead or dying wood, key components in natural forests, has crucial roles in biodiversity of forest ecosystems. They provide habitat to many species such as invertebrates, insects, birds and mammals that use dead wood as a food source and or shelter (Elton 1966; Maser and Trappe 1984; Harmon et al. 1986; Keenan et al. 1993; Cso´ka 2000; Siitonen et al. 2001; Chambers 2002). Vanderwel et al. (2007) studied the effect of partial clear-cut harvesting on birds in North America and reported that its biodiversity and quantity were affected.

Dead wood (DW) affects the regeneration by increasing the nutrient, organic matter and carbon storage to forest ecosystems (Habashi 1997; Motta 2006; Sefidi 2006), and also increasing the soil moisture (Harvey et al. 1981; Kruys and Jonsson 1999).

The amount of dead wood occurring in natural forest is related to the forest type, age, the kind and intensity anthropogenic disturbances in forest, soil and climatic factors (Christensen et al. 2003). Close natural silviculture practices put more emphasis on dead wood in forest ecosystems (Lombardi et al. 2008). Intensity of forest management affects the amount of DW (Oakland 1994; Guby and Dobbertin 1996; Green and Peterken 1997; Christensen et al. 2003; Erajaa et al. 2010). DW quantities are much lower in managed forests in comparison with unmanaged old growth forests, as most of the large-sized harvestable timbers were extracted (Green and Peterken 1997; Kirby et al. 1998; Lombardi et al. 2008; Odor and Standova´r 2001).

One of the greatest differences between managed and reserve forests is the volume and composition of dead wood. Forest management is always modified to enhance quality and quantity of dead wood habitats (Siitonen 2001; Gibb et al. 2005; Erajaa et al. 2010). Native species, which are large, long –lived and decay slowly, tend to support a greater diversity of organisms than non-native or short- lived species. The two main native trees in Northern forest in Iran, Beech (*Fagus orientalis* Lipsky.) and oak (*Quercus castaneifolia*) provide valuable dead wood habitats

(Daneshvar 2009).

The quantity of DW has considerably decreased because of the huge exploitation of the old forests starting in the middle of the 19th century. A study was done on DW in north of Iran where it was classified as semiarid climate except in a small bar that has temperate forest (Daneshvar 2009). Sefidi (2006) also indicated the intensity management and intervention rate affects the quality and quantity characteristics of DW. The objective of our survey was to compare the effect of intervention and type of forest management on quality and quantity characteristics of two managed and unmanaged forests.

Materials and methods

Study site

The study area is located in east Giulan Province (west of northern Iran forest bar), at 35 km of south Siahkal. Forests in this region were part of the seven series of Shenroud plan forestry from watershed of 25 in north forest of Iran. This forest was located between longitude 49°46' to 49°59'30" and latitude 36°55'48" to 37°1',20". The entire inventory of 702 parcels called Cheshmeh-sar forest was evaluated for DW volume (Fig. 1). It is a reserve parcel with a few small streams. Some features of the two forests habitat are shown in the Table 1.

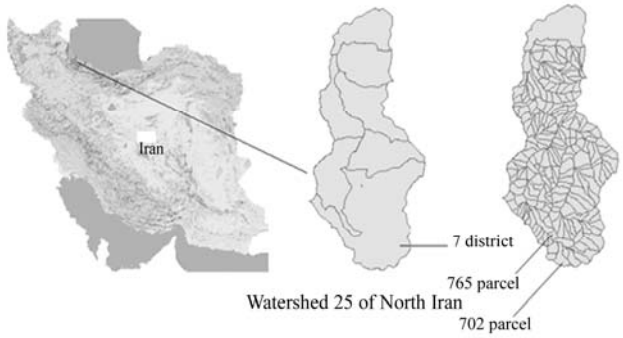

Fig. 1 Location of forest stands investigated in northern Iran

Table 1. Forest habitat features in Cheshmeh-sar and Sardab forests

Forest	Mother stone	Volume (m^3/h)	Min and max altitude	Public order
Cheshmeh-sar	Lime	449.5	850-1250 (m)	eastern
Sardab	mainly lime	358.12	850-1100 (m)	northern

The slope region was often relatively high and had rocky protrusion. Cheshmeh-sar forest was an un-aged forest with 2–3 stages, which the age condition of area trees was categorized from young to middle to old trees. Its forest type was Beech, *hornbeam, Alder*. Managed forests studied, were selected from two adjacent parcels that were homogeneous with Cheshmeh-sar forest. These two parcels were selected because both habitats (managed and reserve forests) were equal. This forest is characterized by a very wet climate. There is heavy precipitation throughout the year and mists are frequent particularly in the spring and summer. The winters are cool and humid with annual precipitation 1,557 mm. Most the rainfall is received during August to May. June and July (34.6°C) are the hottest months whereas January and February (6.4°C) is the coldest (Taheri-Abkenar 2005).

Sampling method

To access the quantity and quality characteristics of DW, in two forests, a survey conducted in the forest region revealed that a 100% of inventory for the harvest of all desired features of DW had a diameter of the 12 cm and more. Factors considered to be compared in two forests included diameter and height (to achieve volume), species, shape, location of fracture, and quality of DW. Location of fracture was considered as a factor to review the effect of intervention and management in stand properties. Also, DW quality was assessed to indicate the effect of human interventions on the speed of decomposition processes and ecosystem dynamics. DW was divided into three quality states: hard, hollow and soft; and the soft DW into four states. The different characteristics of DW quality are listed in Table 2.

In terms of shape, DW according to the observations in both the forest was divided into two overall shapes (Fig. 2): the standing (snag) and fallen (log). As for the fracture locations, the number of DW that was eradicated in two forests was counted.

Fig. 2. Types of Dead Wood in study area. 1. Snag; 2. Hollow DW; 3. Eradicate DW

Table 2. Different quality characteristics of DW in the region

Quality states in DW	Characteristics
Hard	Tree was at the beginning of the decay process.
Hollow	Tree had already passed the decay stage.
Soft(4 steps)	Soft decay was considered as the intense activity of microorganisms in the advanced stages, and woody tissues were quit soft and added to the soil.

The quality and quantity characteristics of dead wood in managed and untouched forests were compared. When data followed a normal distribution and group variances did not differ, independent sample t-test was used; otherwise chi- square test used as well. SPSS 15 was used as analytical software.

Results

Living trees and Dead wood Quantities

The results of inventory DW are listed in the Table 3. In both forests, DW species compositions were composed from three species of Beech, Hornbeam and Alder. The Beech contains a high volume of DW. In Cheshmeh-sar, conservation forest, the most frequent DW were seen was measured in the lower diameter classes (diameter class of 15 to 35), but in Sardab forest this process was irregular and formed from all the diameter classes (Figs. 3 and 4). Fig. 5 shows the percent of species incorporated in Cheshmeh-sar and Sardab forests.

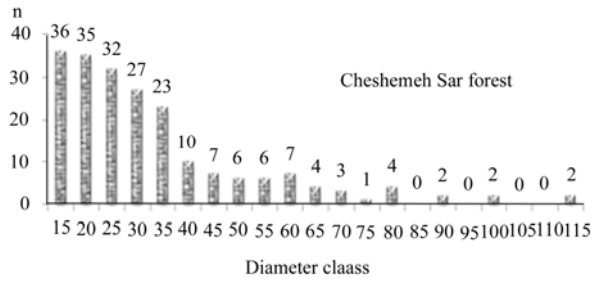

Fig. 3 DW frequency in difference diameter classes on the Cheshmeh-sar forest

There was a significant difference (p=0.026) between two habitats in terms of volume. The volume per hectare of DW estimated in Cheshmeh-sar conservation forest and Sardab forest was 2.55 m³ and 1.76 m³, respectively.

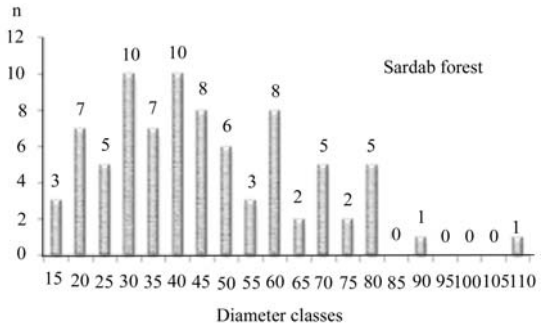

Fig. 4 DW frequency in difference diameter classes on the Sardab forest

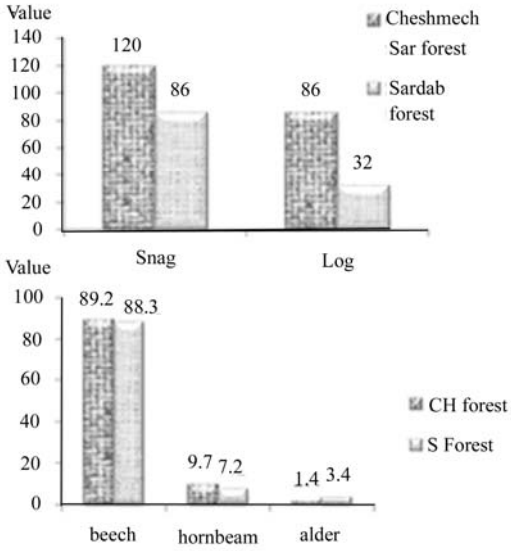

Fig. 5 Percent of DW species incorporated in Cheshmeh-sar and Sardab forests (lower). Frequency of snag and log in Cheshmeh-sar and Sardab (uper).

Type of Dead wood

As for shape of DW, there was a statistical level more than 0.05 (p=0.0587) between site and shape of DW. Therefore, there was no significant difference between two habitats.

Table 3. DW inventory in Cheshmeh-sar and Sardab forests

Forest	Total volume (m³)	Number Per hectare	Volumem³ Per hectare	snag Frequency (%)	snag Volume (%)	log Frequency (%)	log Volume (%)	DW Wide(%)
Cheshmeh-sar	207.47	2.56	2.55	42	22.45	58	77.55	14.45
Sardab	142.73	1.02	1.76	38.56	37.77	61.44	62.23	37.35

The close observations reached the results so that in Cheshmeh-sar forest 12.1% of DW was eradicated, while in Sardab forest 30.1% of DW found to be in this state. This finding showed a significant difference between the percent of DW in

Cheshmeh-sar forest and Sardab forest (p=0.00).

The result of soft quality different states in Cheshmeh-sar and Sardab forest was shown on the Fig. 6. According to the results, a significant difference between two habitats was observed (p=0.018).

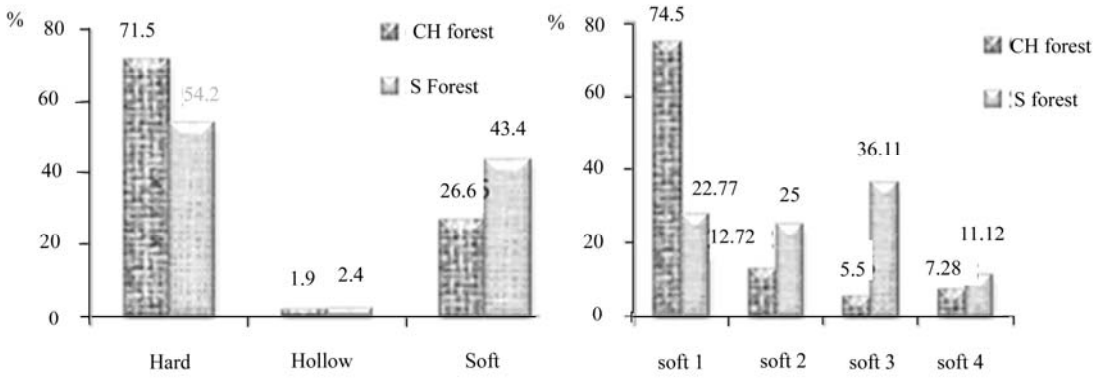

Fig. 6. Quality degree (%) of dead trees that formed in Cheshmeh-sar and Sardab forest (Left) and percent of soft quality between Cheshmeh-sar (CH) in comparison with Sardab forest (S) (right).

The results of the DW amount investigation in the different places from East, Center and West of Iran's northern forest band with different management history are listed in Table 4.

Table 4. DW amount in the different places of northern Iran

Forest	Place	Management history	Volume per ha	Area (ha)	References
Shastkollate	East	unmanaged	66.81	16.9	(Daneshvar 2009)
Vaz	Center	unmanaged	32.67	25	(Habashi 1997)
Chelir	Center	unmanaged	16.5	16.9	(Zolfaghari 2004)
Namkhaneh	Center	managed	5.17	38	(Sefidi 2006)
Patom	Center	managed	3.17	54.8	(Sefidi 2006)
Cheshmeh-sar	West	unmanaged	2.56	81	Our study
Sardab	West	managed	1.02	80	Our study

Discussion

Living and deadwood volumes

This study aimed to investigate the influence of human being on the forests and to compare the dead wood (DW) conditions in two forests with different management history, including virgin forest and harvested forest. Green and Peterken (1997) found that the amount of DW depends on the management intensity of forests while other researchers (Fridman and Walheim 2000; Siitonen et al. 2000; Lombardi et al. 2008) showed that the amounts of DW in the managed forests are between 2 to 30 percent of DW quantity in the unmanaged forest (normally 10%). This result was relatively similar to the finding of Butler and Schlaepfer (2004) that proposed an optimal value of 10% for dead wood. According to our result, a significant difference between the volume of DW area of Cheshmeh-sar conservation forest and that of Sardab forest was observed. The volume per hectare of DW was estimated at 2.55 m^3 in Cheshmeh-sar conservation forest and 1.76 m^3 in Sardab forest (more or less 1 percent). A study (Daneshvar 2009) in Iran showed that DW in virgin forest of Vaz located in the north was 32.67 $m^3 \cdot ha^{-1}$, of which the percentages of snag (standing DW) and fallen DW (log) were 23% and 77%, respectively. He found that the this volume for Chelir forest with less intervention was estimated at 16.5 $m^3 \cdot ha^{-1}$ (Daneshvar 2009). Ammer (1991)stated that the volume of dead wood is around 1%-2% of the whole forest yield. Gibb et al. (2005) proposed 5% of the yield in managed forests should be kept to generate dead wood. Forest management can strongly reduce the occurrence of dead wood and make it come down to its absence completely (Pedlar et al. 2002).

As it can be seen in Table 4, DW values were reduced from east to west in Iran's northern forest band. This difference in the amount of DW is probably due to various natural events e.g. climatic factors and also a variety of disturbance regimes in each of these areas. A study conducted (Atici et al. 2008) in the forest of northern Turkey revealed that the dead beech wood volume survey was 22.87 m^3 per hectare. Values obtained from DW in the needle leaf forests were much higher than DW values of the broadleaved forests (Atici et al. 2008). One reason for this difference could be due to the slower decay rate in the needle leaf forests than the broadleaved forests, which naturally affects the accumulation of DW in the broadleaved forests. A Survey in European forests showed the average of total dead wood volume in production was less than 10 m^3/ha (Christensen et al. 2005). The amount of dead wood in Iranian forests was less than or similar to those in Europe. The human access (fuel woods) and no interest to dead wood in forest management may be the reason of that (Taheri-Abkenar 2005).

Pedlar et al.(2002) stated the input of DW is much lesser in the temperate broadleaved forests than in needle leaf forests due to the higher decay rate, which leads to differences in climate and other differences between biomes.

The results of our study showed the impact of management and human access on the DW volume. The volume of live trees in

Cheshmeh-sar forest was more than Sardab forest. And this, in addition to the management effect, could be a cause of the DW for Cheshmeh-sar forest to have more volume than Sardab forest.

Type of dead wood

Our study results showed that in both Cheshmeh-sar forest and Sardab forest, abundance of dead Beech wood have similar conditions. The highest percent of living trees in both forests was composed of Beech species to which most of DW naturally belong. Also proportions of thick DW in Cheshmeh-sar forest and Sardab forest were 23.27% and 62.65%, respectively. High percent of DW in Sardab forest could be possibly due to human inaccessibility and lack of manipulation; however, natural events such as wind, storms and other similar climate changes added more damage to thick Beech trees in comparison with Cheshmeh-sar forest. More than 50% of dead wood occurred as thick diameter dead wood, and 50% as snags ((Debeljak 2005). Existence of 30.1% eradicating DW in Sardab forest in contrast to 12.1% in Cheshmeh-sar forest implied the impacts of management and human access to this ecosystem. In Cheshmeh-sar forest, many DW have been removed due to competition for light that can cause Beech trees to be in a larger number than the Beech DW. We found unmanaged forest had dead wood in almost all classes of decomposition. This finding is agreed to Christensen et al. (2003).

According to our results, the diameter classes in Cheshmeh-sar forest show a regressive curve that consistent with the diameter curve in uneven aged forest while that of Sardab forest shows irregular curve. In connection with DW shape, no significant difference in two forests suggests that the management type almost has no impact on the standing or fallen dead wood. In contrast with Cheshmeh-sar forest, Sardab forest, had more percent of the fallen DW. Lombardi et al. (2008) found similar results in central Apennines (Molise, Italy) with Mediterranean forest.

Sefidi (2006) represented higher level of the fallen DW in Namkhaneh forest than in Pattom forest, which is the sign of active decay in Namkhaneh forest. In Sardab forest, the majority (75%) of standing dead wood was thick, but in Cheshmeh-sar forest only 20.7% of standing dead wood was thick. The existence of the large standing dead woods resulted in appropriate condition of wildlife (Beets et al. 2008; Lombardi et al. 2008), and abundance of conspicuity for this type of the DW implied the optimum condition of Sardab forest.

The results presented here are important in helping to inform the future debates and to guide Silvicultural management affecting dead wood in Iran. It seems that, forest management in general and human access in particular (fuel woods) are considered to be the main reasons of differences in dead wood, between the managed and unmanaged forest.

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